July 12, 1960 L. SCHMIDT ET AL 2,945,144

SECONDARY ELECTRON MULTIPLIERS

Filed July 11, 1958

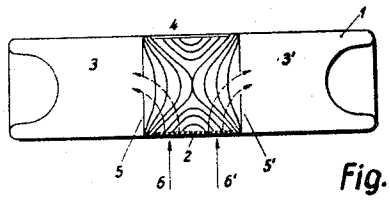


Fig.1

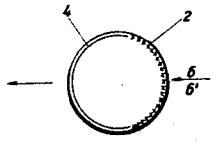


Fig.2

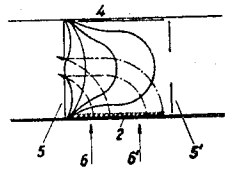


Fig.3

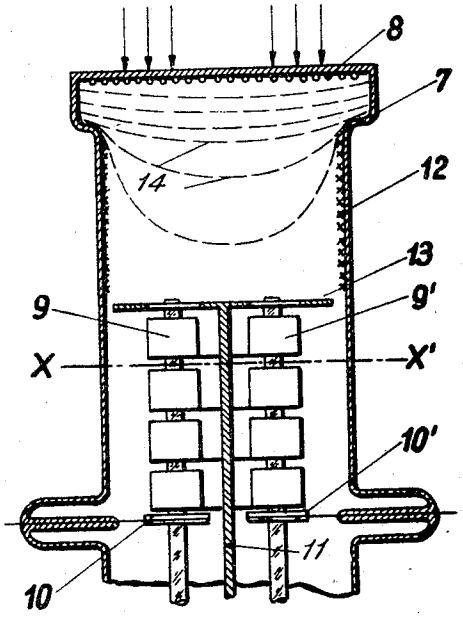


Fig.4

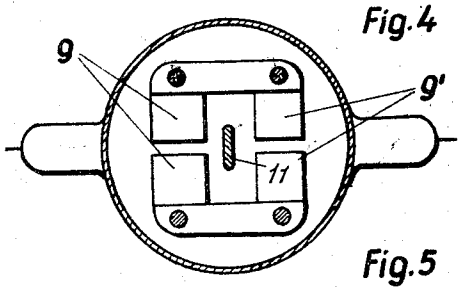


Fig.5

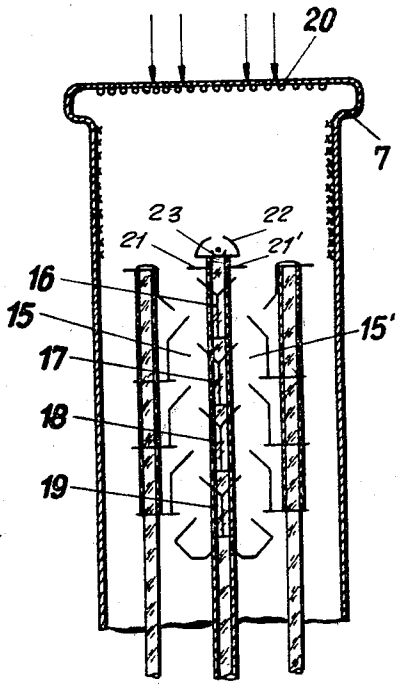


Fig.6

Inventors:

Erwin Schmidt

Eberhard Adler.

United States Patent Office 2,945,144 Patented July 12, 1960

2,945,144

SECONDARY ELECTRON MULTIPLIERS

Lothar Schmidt and Eberhard Hahn, Jena, Germany, assignors to VEB Carl Zeiss Jena, Jena, Germany

Filed July 11, 1958, Ser. No. 748,101

8 Claims. (Cl. 313—95)

In photo-electric measuring, use is frequently made of two separate light beams. If not bright enough, these beams require being intensified, for instance by means of secondary electron multipliers. To this end, two separate multipliers have generally been applied, but a secondary-electron multiplier is known which comprises two multiplier systems and two cathodes in one evacuated vessel whose vacuum-technical properties serve the purposes of both systems. Yet, the existence in this so-called two-way multiplier of two separate photocathodes and the fact that the two multiplier systems are not symmetric to each other may, however, have unwanted and deleterious consequences.

The present invention, which aims at providing a multisystem multiplier exempt from the disadvantages inherent in the known constructions, equips a secondary-electron multiplier having one photocathode and two or more dynode systems disposed in one evacuated vessel, with electrostatic or magnetic deflecting means of great directional beam effect influencing the field in close proximity to the cathode and directing the photo-electrons released by separate light beams from the common photocathode into one each of the systems. It is advantageous to coordinate the electrode systems symmetrically to the cathode. When using two multiplier systems, it is possible, for instance in the space surrounding the cathode, by applying corresponding potentials to the input electrodes of the two multiplier systems in connection with an auxiliary cathode at cathode potential, which may be the cathode itself, to produce such a field distribution that two light beams incident at a certain distance from each other convey the photo-electrons released from the cathode surface in different, preferably opposite directions and, accordingly, into one each of the multiplier systems.

A multiplier construction of this kind offers considerable advantages over known apparatus. The spectral distribution of the sensitivity of the photocathode in the multiplier apparatus according to the invention holds good for all photo-electrons released in this apparatus. Changes in the properties of the photocathode also take effect on all released photo-electrons alike. Furthermore, the symmetrical arrangement of the multiplier systems permits the thermal dark current of the photo-cathode to be distributed statistically uniformly over all systems. This symmetry moreover guarantees a uniform formation, which results in uniform properties of the entire valve with respect to vacuum, fatigue and amplification factor. The symmetric construction of the systems offers manifold possibilities of comparative photometric measurements, particularly when compensation and coincidence methods are concerned, since in apparatus effecting such measurement also the uniform distribution of the capacities is particularly advantageous. A still further advantage consists in a comparatively simple construction. Finally, conditions of linearity as well as the dependence of the over-all amplification on the over-all voltage can evidently be correlated individually and much better in

symmetric systems than in single multipliers or in a valve with separate and asymmetric cathodes.

In the accompanying drawings, which represent several constructional examples of multipliers according to the invention, Figs. 1 and 2 show schematically a multiplier system in longitudinal and in cross section, respectively. Fig. 3 illustrates the lines of force of a particular case, and Figs. 4, 5 and 6 show two further embodiments.

The two-system multiplier arrangement illustrated in Figs. 1 and 2 has in a cylindrical evacuated vessel **1** a transparent cathode **2** in which two multiplier systems **3** and **3'** are symmetrical. Opposite the cathode **2** is an auxiliary electrode **4** to which cathode potential is applied and which constitutes together with the cathode a doubly slotted cylinder. When the same potential, i.e. cathode potential, is applied to these cylinder parts, they produce an electron-optical effect which is practically that of an undivided cylinder. Applying to the input electrodes **5**, **5'** of the two multiplier systems positive potential relative to the cathode calls forth the potential lines schematically shown in Fig. 1, viz. an anticlinal formation typical with electrostatic electron lenses designed for electrodes of the kind of **3—2**, **4—3'**. If two light pencils **6**, **6'** spaced apart are directed to the surface of the cathode **2**, the photo-electrons they release from the cathode **2** are deviated by the potential field effect into different directions. These photo-electrons travel through the apertures in the electrodes **5** and **5'** and arrive in one each of the two multiplier systems. An arrangement of this kind permits in a comparatively simple manner to obtain effects which are advantageous in measuring technique, it being possible, for instance, to alternately deviate also the two photo-electron fluxes released by the light pencils **6** and **6'** into one of the multiplier systems by alternately applying negative potential to one of the electrodes **5** and **5'**. This process will now be explained with reference to Fig. 3, which illustrates the magnetic flux typical of the case here concerned. According to the adjustment of the potential of the electrodes **5** and **5'** relative to that of the cathode, it is also possible, for instance, to direct the electrons released by the light pencil **6** through the aperture in the electrode **5'**, while the photo-electrons released by the light pencil **6'** are intercepted by this electrode **5'**. By reversing the polarity of the electrodes **5** and **5'**, the electrons released by the light pencil **6'** can be directed in the same manner by way of the aperture in the electrode **5** into the multiplier system **3**, while the electrons released by the light pencil **6** are intercepted by the electrode **5**.

The constructional examples illustrated in Figs. 4, 5 and 6 show that the multiplier systems can be coordinated to common cathode also in another manner. In the arrangement represented in Fig. 4, a section through line X—X' of which is shown in Fig. 5, an evacuated vessel **7** contains a transparent cathode **8** and two symmetrical multiplier systems **9** and **9'**, which are parallel to each other and have collector electrodss **10** and **10'**, respectively. To avoid mutual interference, the multiplier systems are separated from each other by a web **11** to which is supplied a potential precluding changes of the electrons from the one system to the other. Suitably chosen potential relations between the cathode and the auxiliary electrodes **12** and **13** permit the field in the space around the cathode to be given a shape as indicated by the dash-lines **14**. It is of importance in this case to obtain quite near the cathode a field distribution guaranteeing a comparatively high directional-beam value. Photo-electrons not emanating at right angles to the cathode surface are thus prevented from getting into the wrong multiplier system. High directional-beam values can be obtained in different ways. In the arrangement according to Figs. 4 and 5, the

desired effect is arrived at by a relatively strong field near the cathode.

The embodiment shown in Fig. 6 has two multiplier systems 15 and 15' so placed opposite to each other that both systems have in each stage one electrode (16, 17, 18, 19) in common. Between the cathode 20 and the input electrodes 21, 21' of the multiplier systems is disposed another auxiliary electrode, 22, which may contain in a small cup 23 the evaporation coil for the cathode-support metal.

We claim:

1. A secondary electron multiplier for amplifying the photoelectric current of at least two separate beams of light, comprising in an evacuated vessel a common photocathode, a separate dynode system for each of said beams, and deflecting means disposed in close proximity to said cathode, said deflecting means having a great directional-ray effect and directing the photo-electrons released by said separate beams from said photocathode into the corresponding of said separate dynode systems.

2. A secondary electron multiplier for amplifying the photoelectric current of at least two separate beams of light, comprising in an evacuated vessel a common photocathode, a separate dynode system for each of said beams, said dynode systems being arranged symmetrically to said photocathode, and deflecting means disposed in close proximity to said cathode, said deflecting means having a great directional-ray effect and directing the photo-electrons released by said separate beams from said photocathode into the corresponding of said separate dynode systems.

3. A secondary electron multiplier for amplifying the photoelectric current of two separate beams of light, comprising in an evacuated vessel a common photocathode, two dynode systems and deflecting means in close proximity to said cathode, said deflecting means having a great directional-ray effect and directing the photo-electrons released by said separate beams from said photocathode into the corresponding of said dynode systems, said photocathode having a cylindrical surface, said surface and those input electrodes of said two dynode systems to which positive potential is applied relative to said cathode constituting an electrostatic lens.

4. A secondary electron multiplier for amplifying the photoelectric current of two separate beams of light, comprising in an evacuated vessel a common photocathode, two dynode systems and deflecting means in close proximity to said cathode, said deflecting means having a great directional-ray effect and directing the photo-electrons released by said separate beams from said photocathode into the corresponding of said dynode systems, said photocathode having a spherical surface, said surface and those input electrodes of said two dynode systems to which positive potential is applied relative to said cathode constituting an electrostatic lens.

5. A secondary electron multiplier for amplifying the photoelectric current of two separate beams of light, comprising in an evacuated vessel a photocathode, two dynode systems and deflecting means in close proximity to said cathode, said deflecting means having a great directional-ray effect and directing the photo-electrons released by said separate beams from said photocathode into the corresponding of said dynode systems, said photocathode being divided into at least two parts insulated from each other to which cathode potential can be applied selectively.

6. A secondary electron multiplier for amplifying the current of two separate beams of light, comprising in an evacuated vessel a photocathode, two dynode systems and deflecting means in close proximity to said cathode, said deflecting means having a great directional-ray effect and directing the photo-electrons released by said separate beams from said photocathode into the corresponding of said dynode systems, the surface of said photocathode being divided into at least two parts insulated from each other to which a potential different from that of said cathode can be applied singly or in pairs.

7. A secondary electron multiplier for amplifying the current of two separate beams of light, comprising in an evacuated vessel a photo cathode, two dynode systems and deflecting means in close proximity to said cathode, said deflecting means having a great directional-ray effect and directing the photo-electrons released by said separate beams from said photocathode into the corresponding of said dynode systems, said photocathode having a cylindrical surface, said surface and the input electrodes of said two dynode systems to which the same positive potential is applied relative to said cathode constituting an electrostatic lens.

8. A secondary electron multiplier for amplifying the current of two separate beams of light, comprising in an evacuated vessel a photocathode, two dynode systems and deflecting means in close proximity to said cathode said deflecting means having a great directional-ray effect and directing the photo-electrons released by said separate beams from said photocathode into the corresponding of said dynode systems, said photocathode having a spherical surface, said surface and the input electrodes of said two dynode systems to which the same positive potential is applied relative to said cathode constituting an electrostatic lens.

References Cited in the file of this patent

UNITED STATES PATENTS

2,160,797	Teal	May 30, 1939
2,431,510	Salinger	Nov. 25, 1947
2,433,700	Larson	Dec. 30, 1947

FOREIGN PATENTS

748,720	Germany	Nov. 8, 1944